GLAST Science Overview

Section 4

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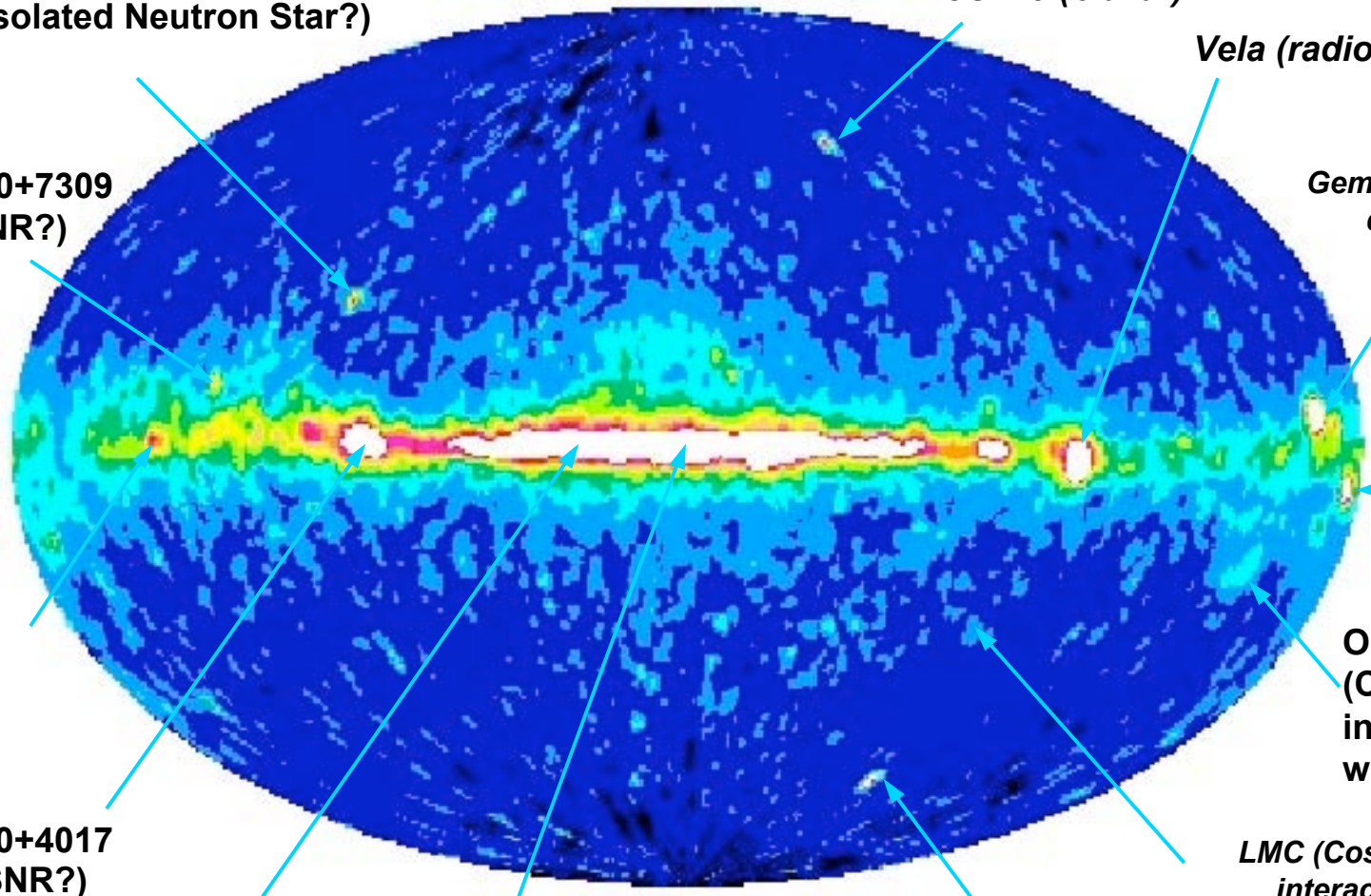
The High Energy Gamma-Ray Sky



3EG J1835+5918
(Isolated Neutron Star?)

3C279 (blazar)

Vela (radio pulsar)

3EG J0010+7309
(CTA 1 SNR?)

Geminga (radio-quiet pulsar)

Orion Cloud
(Cosmic ray interactions with ISM)

3EG J2020+4017
(γ Cygni SNR?)

LMC (Cosmic ray interactions with ISM)

3EG J1837-0423
(unidentified transient)

3EG J1746-2851 (Galactic Center?)

PKS 0208-512 (blazar)

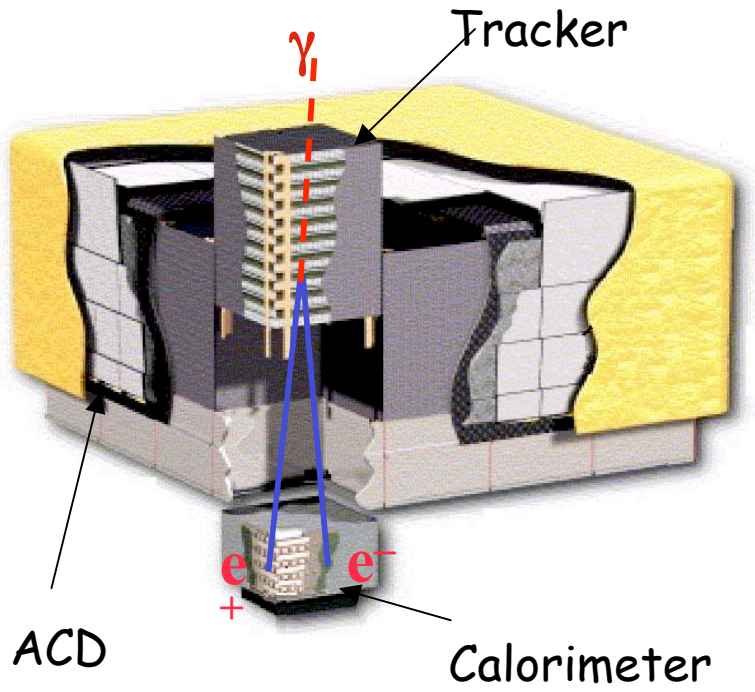
Science Topics

The production of high energy gamma-rays requires very high energy particles -> study of the most energetic and extreme astrophysical sources.

- ***Active Galactic Nuclei***
- ***Gamma-ray bursts***
- ***Supernova remnants***
- ***Pulsars***
- ***Tests of fundamental physics, quantum gravity etc***
- ***New source classes!***

GLAST Instruments - LAT

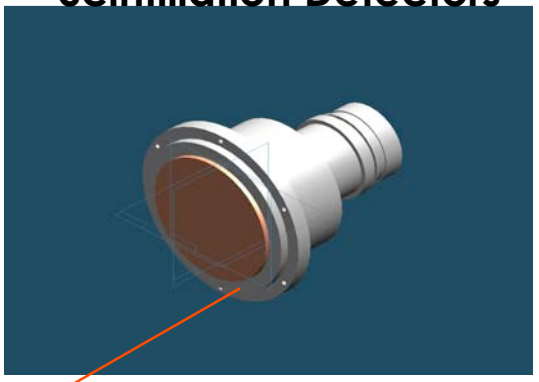
- Precision Si-strip Tracker (TKR)
  18 XY tracking planes. 228 μm pitch
  Measure the photon direction; gamma ID.
- Hodoscopic CsI Calorimeter(CAL)
  Array of 1536 CsI(Tl) crystals in 8 layers. Measure the photon energy; image the shower.
- Segmented Anticoincidence Detector (ACD) 89 plastic scintillator tiles.
  Reject background of charged cosmic rays; segmentation removes self-veto effects at high energy.



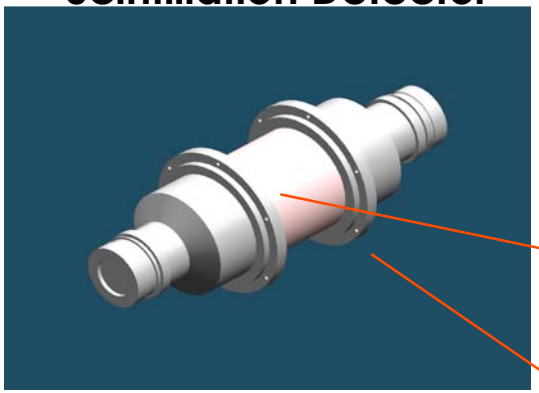
Systems work together to identify and measure the flux of cosmic gamma rays with energy 20 MeV - >300 GeV.

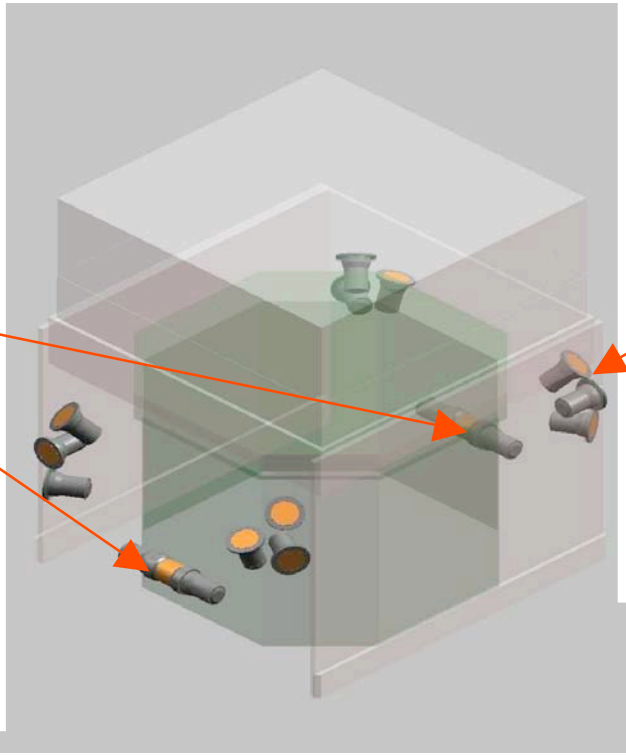
GLAST Instruments - GBM

(12) Sodium Iodide (NaI) Scintillation Detectors



Bismuth Germanate (BGO) Scintillation Detector





Major Purpose

- Provide high-energy spectral coverage (150 keV – 25 MeV) to overlap LAT range over a wide FoV

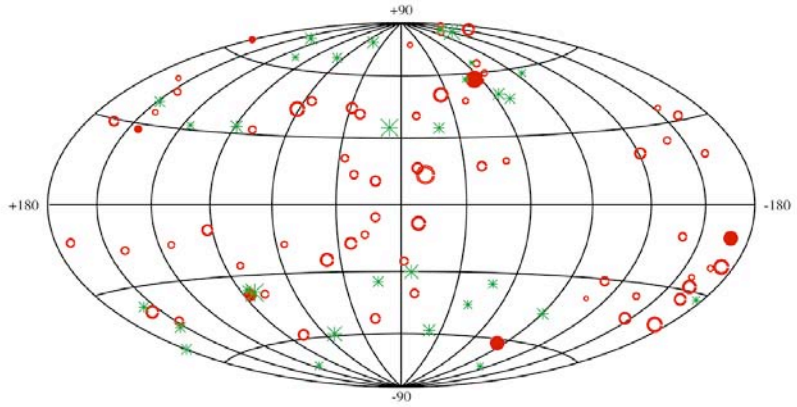
Major Purpose:

Provide low-energy spectral coverage in the typical GRB energy regime over a wide FoV (10 keV – 1 MeV)

Provide rough burst locations over a wide FoV

Active Galactic Nuclei

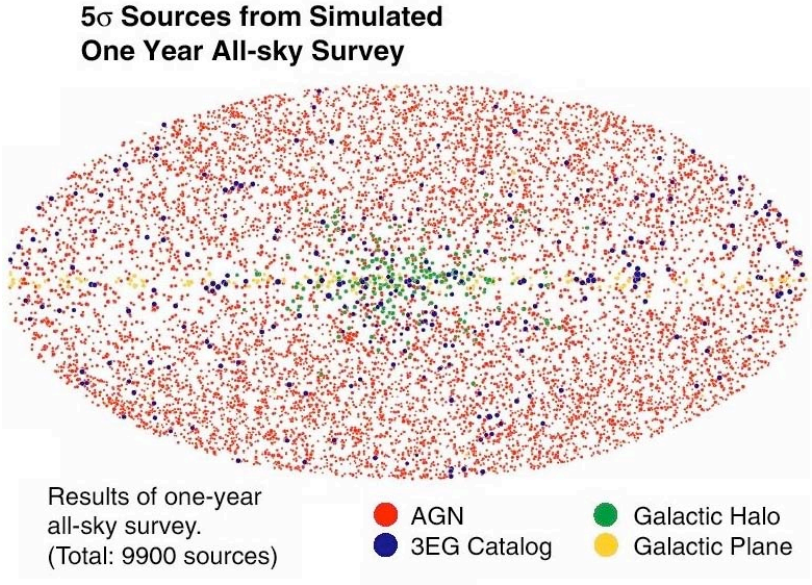
- ***Enormous energy output coming from the compact core of some galaxies.***
- ***Generally believed to be powered by accretion onto super-massive black holes (10^6-10^{10} solar masses).***



○ = EGRET AGN seen sometimes

● = EGRET AGN seen always

✳ = EGRET unidentified high-latitude variables

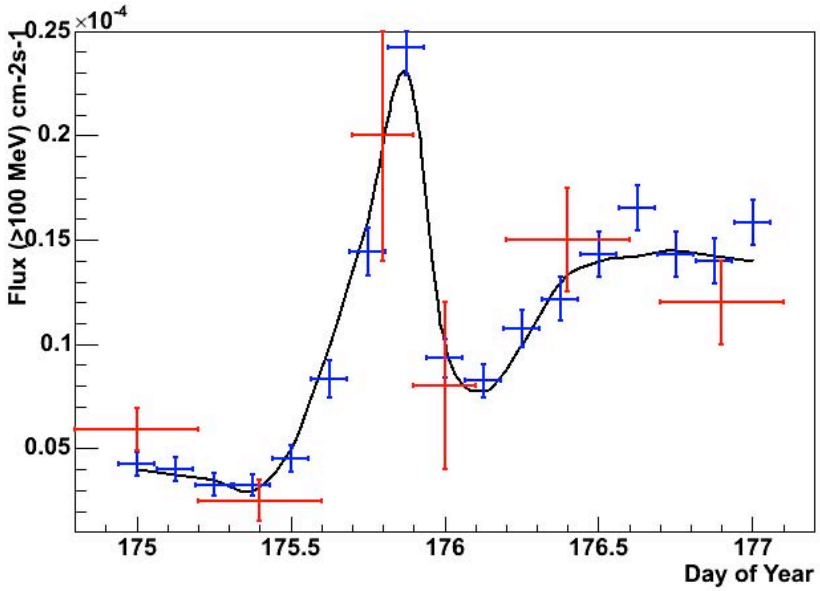


EGRET saw ~70 AGN, mostly only during flares. GLAST will detect very many more (several thousand).

AGN Variability

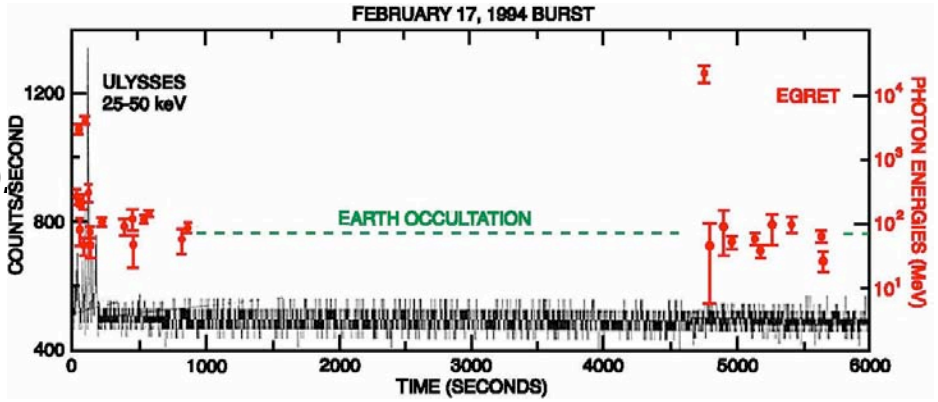
- ***AGN are highly variable (gamma-ray variability seen on timescales from 15 minutes to months).***
- ***Strength and phasing of flares at different wavelengths provides powerful insights into the mechanisms that produce the emission.***
- ***The large field of view and efficient operating mode open important new discovery space – monitor all AGN all the time with much better sensitivity !!***

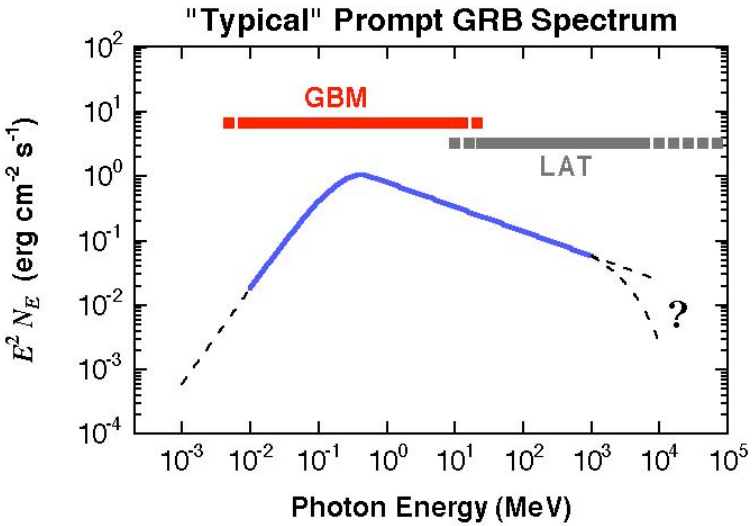
EGRET observations (red points) of a flare from PKS 1622-297 in 1995 the black line is a lightcurve consistent with the EGRET observations and the blue points are simulated LAT observations (in scanning mode).



Gamma-Ray Bursts

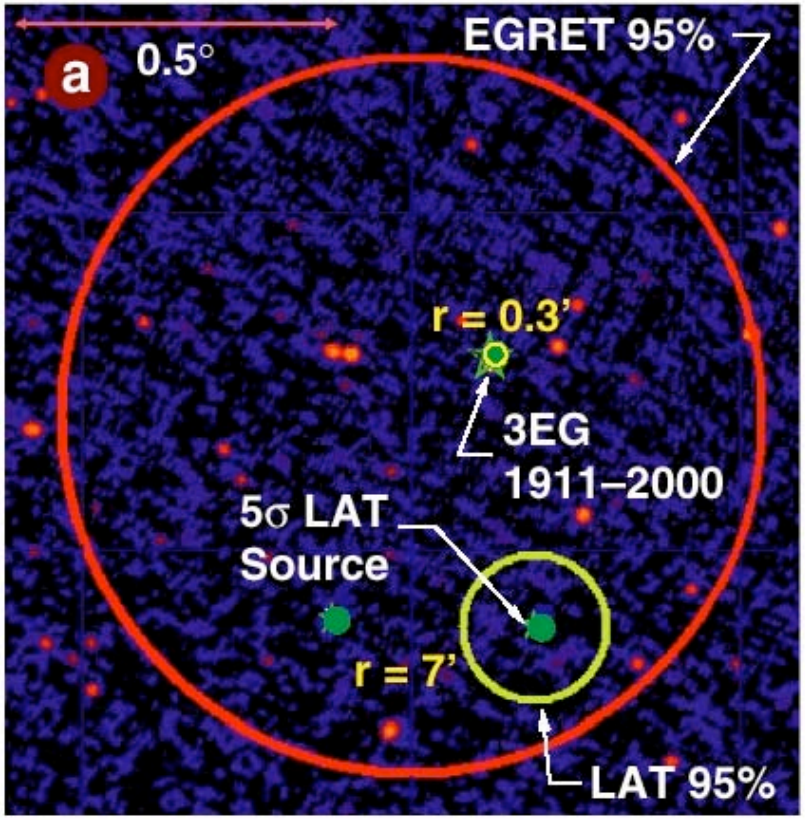
- ***Short, very bright flashes of gamma-rays followed by faint fading afterglows at lower energies (radio, optical and X-ray)***
- ***Very rapid variability + high flux implies a huge photon density.***
- ***EGRET saw 45 high energy gamma-ray photons (in total) from several GRB, including an 18 GeV photon 75 mins after the burst.***
- ***GBM observations are crucial, (a) for connecting LAT observations of GRB to the traditional energy range, and (b) can detect bursts outside the LAT's field of view. Allowing the LAT to request a repoint for particularly interesting bursts.***



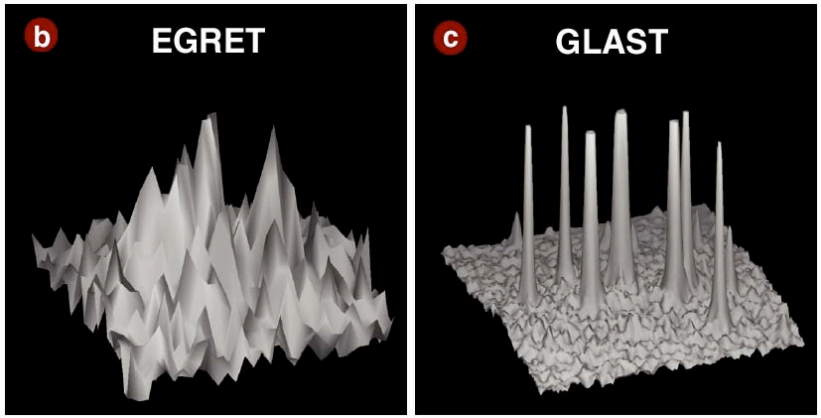


New Source Classes

- ***172 of the 271 sources in the EGRET 3rd catalog are "unidentified"***



GLAST will provide accurate GeV source locations making it much easier to identify the LAT objects with known counterparts at lower energies.



Summary

- ***GLAST will transform our current view of the high energy gamma-ray sky.***
- ***The GeV source catalog will increase by more than an order of magnitude, with many more objects from known classes of GeV emitters and also discovery of new GeV source classes.***
- ***Efficient observing mode, improved sensitivity and increased effective area combine to provide superb monitoring of the GeV sky on timescales from hours to years.***
- ***Greatly improved sensitivity at higher energies than were accessible by EGRET will open up a unexplored region of the EM spectrum (discovery potential!!) and will ensure a much closer overlap with the ground based gamma-ray instruments.***

Wide Energy Range

- ***The energy range of the satellite-based GeV instruments will overlap with the ground-based TeV instruments for the first time.***
- ***Likely to be much more overlap between the TeV and GeV source catalogs.***